

## **REMARKS**

### **I. Introduction**

With the addition of new claim 22, claims 12 to 22 are pending in the present application. In view of the foregoing amendments and the following remarks, it is respectfully submitted that all of the presently pending claims are allowable, and reconsideration is respectfully requested.

### **II. Objection to the Drawings**

The Office Action states that the phrase "direct injection of a fuel into a combustion chamber of the internal combustion engine" recited in claim 12 must be shown or the feature(s) canceled from the claims." Office Action at p. 2. Applicants note that none of the claims recites "direct injection of a fuel into a combustion chamber of the internal combustion engine."

The Office Action also alleges that an "entry plane" and a "projection" must be illustrated in the drawings. Applicants have amended Figure 3 such that a numeric label has been provided for the "entry plane." No new matter has been added. As regards the term "projection," it is respectfully submitted that at least Figure 3 illustrates the relationship between the flattened face 29 and the entry plane 110 as set forth in the phrase "an entry plane of the outlet orifice . . . arranged such that the entry plane is completely covered by a projection of the flattened face into the entry plane in a direction perpendicular to the flattened face" as recite in claim 12.

In view of the foregoing, it is respectfully submitted that the drawings fully comply with the requirements of 37 C.F.R. § 1.83(a). Withdrawal of this objection is therefore respectfully requested.

### **III. Objection to the Specification**

The Specification was objected to as allegedly failing to provide proper antecedent basis for the claimed subject matter. The Office Action alleges that the terms "entry plane" and "projection" recited in claim 12 should be included in the Specification. Applicants have amended the Specification to expressly include the terms "entry plane" and "projection." No new matter has been added. Applicants respectfully request withdrawal of this objection.

**IV. Rejection of Claim 19 Under 35 U.S.C. 112, Second Paragraph**

Claim 19 was rejected under 35 U.S.C. § 112, second paragraph as indefinite for allegedly failing to particularly point out and distinctly claim the subject matter of the invention. While Applicants do not agree with the merits of this rejection, to facilitate matters, claim 19 has been amended herein without prejudice to recite that the spray element is a part of the valve seat element. Amended claim 19 is fully compliant with 35 U.S.C. § 112, and Applicants respectfully request withdrawal of this rejection.

**V. Rejection of Claims 12 to 21 Under 35 U.S.C. § 103(a)**

Claims 12 to 21 were rejected under 35 U.S.C. § 103(a) as unpatentable over the combination of U.S. Patent No. 4,890,794 ("Imafuku et al.") and U.S. Patent No. 5,878,962 ("Shen et al.") and as unpatentable over U.S. Patent No. 5,996,912 ("Ren et al."). For the reasons more fully set forth below, Applicants respectfully submit that the combination of Imafuku et al. and Shen et al. does not render obvious claims 12 to 21 and that Ren et al. do not render obvious claims 12 to 21 for the reasons set forth below.

Claim 12 relates to a fuel injector for a fuel injection system of an internal combustion engine. Claim 12 recites that the fuel injector includes an energizable actuating element, a valve needle that is axially movable along a longitudinal axis of a valve, a fixed valve seat, a valve seat element including an orifice following downstream from the fixed valve seat, and a valve closing section arranged on a downstream end of the valve needle and for working together with the fixed valve seat for opening and closing the valve, the fixed valve seat designed on the valve seat element. Claim 12 further recites that the fuel injector includes a flattened face running perpendicular to the longitudinal axis of the valve and being arranged on the downstream end of the valve closing section downstream from the fixed valve seat. Claim 12 also requires a swirl-producing element arranged upstream from the fixed valve seat, the flattened face including a diameter  $d$  that is greater than a diameter  $D$  of an outlet orifice. Claim 12 as amended herein without prejudice recites that an entry plane of the outlet orifice is arranged such that the entry plane is completely covered by a projection of the flattened face into the entry plane in a direction perpendicular to the flattened face. Support for the amendment to claim 12 may be found, for example, in Figure 3.

The Office Action alleges that Imafuku et al. disclose a fuel injector comprising: an energizable actuating element 14, a valve needle 27, a fixed valve seat 48, a valve seat element 9, 55, an orifice 54a, b, a valve closing section 47, a flattened face (downstream end of 45), an outlet orifice (outlet of orifice 54 a, b). The Office Action admits that Imafuku et al. do not disclose a swirl-producing element. The Office Action alleges that Shen et al. to disclose a swirl-producing element 38, 48 upstream of a fixed valve seat 34.

Imafuku et al. do not disclose, or even suggest, that an entry plane of an outlet orifice is arranged such that the entry plane is completely covered by a projection of a flattened face into the entry plane in a direction perpendicular to the flattened face as recited in amended claim 12. Imafuku et al. allegedly provide a valve needle 27 which ends downstream from a valve seat 48 in a cylindrical tang 45. The cylindrical tang 45 is located at a downstream end of valve needle 27. A cylindrical nozzle body opening 50 is formed between cylindrical nozzle-body 43 and valve seat face 49. The opening allegedly provides a constant cross-section along the length of the tang 45. Col. 3, lines 1 to 5. The cylindrical tang 45 ends above the disk-shaped perforated body 55. Spray-discharge orifices 54a,b are provided in the perforated body 55. Spray-discharge orifices 54a,b are not closed to ensure an unobstructed inflow of fuel into spray-discharge orifices 54a,b by the use of cylindrical tang 45 and the ring gap around the tang 45. The spray-discharge orifices 54a,b are selectively introduced in the perforated body 5 at **an offset relative to cylindrical tang 45**, without overlap. Fig. 2; col. 4, line 60 to col. 5, line 2. If the bottom of the tang 45 were projected perpendicularly thereto, the entry plane (unnumbered but located in the same plane as element 59) would not be completely covered by the projection. As a consequence, Imafuku et al. do not disclose, or even suggest, that an entry plane of an outlet orifice is arranged such that the entry plane is completely covered by a projection of a flattened face into the entry plane in a direction perpendicular to the flattened face.

The Office Action merely relies on Shen et al. for purporting to disclose a swirl-producing element 38, 48 upstream of a fixed valve seat. Shen et al. do not disclose, or even suggest, that an entry plane of an outlet orifice is arranged such that the entry plane is completely covered by a projection of a flattened face in a direction perpendicular to the flattened face into the entry plane. Shen et al. do not

have a flattened face. Shen et al., therefore, do not cure the deficiencies of Imafuku et al.

Additionally, the purpose of Shen et al. is to provide constantly swirling fuel upstream of an orifice through the use of a "swirler." Shen et al. require a conical spray pattern which is characterized by a conical sheet of swirling fuel about an axis 66 with substantially only a minor quantity of fuel within the conical sheet of the conical spray pattern. Col. 4, lines 20 to 23. Shen et al. require a smooth transition of radially swirling fuel into a generally shallow conical swirl pattern about seat 34. Col. 4, lines 27 to 31. Shen et al. also state:

In all of these embodiments, it will be appreciated that the swirl pattern afforded by the swirl plate carries through the frustoconical seat when the valve is open, as well as through the orifice in all of its various forms including the vent tubes. This is a result of smooth transitions made between a tangentially flowing fuel which continues its swirl pattern as it advances axially and is then turned in an angular direction. The lack of sharp corners and protuberances avoids flow turbulence and the smooth transition surfaces afford a continuation of the strong swirl effected by the swirl plate as the fuel passes through the open valve.

Col. 5, lines 23 to 32. Shen et al. therefore require a smooth transition of fluid flow for operability. Without a smooth transition, the apparatus described by Shen et al. would be inoperative and the purpose of the apparatus provided by Shen et al. would be defeated.

The Office Action attempts to add the swirl element of Shen et al. to Imafuku et al. Placement of the Shen et al. swirl-producing element 38 in the Imafuku et al. injector would not be performed by a person of ordinary skill in the art as such a placement would not provide a smooth transition and is contrary to the purpose of Shen et al. If the swirl element of Shen et al. could be added to Imafuku et al., and Applicants do not admit that the swirl element can be added successfully, an abrupt transition would occur due to the sharp flat faced bottom face of tang 45. Shen et al. provide for a rounded frustoconical shape to eliminate sharp or abrupt transitions. Addition of the Shen et al. swirl element to Imafuku et al. could not be performed without an abrupt transition as evidenced by the flat face of tang 45 in Imafuku et al. and thus the purpose of the apparatus described in Shen et al. would be defeated. The Office Action alleges that the addition of Imafuku et al. and Shen

et al. would be attempted by a person of ordinary skill in the art because Shen et al. and Imafuku et al. allegedly relate to fuel injectors. Applicants respectfully submit that in order to combine the two references as proposed by the Office Action there must be a specific teaching in the references themselves to do so. Here, there is no such teaching in the references themselves.

On the contrary, Applicants respectfully submit that Shen et al., through its disclosure, teaches away from making the proposed combination. Shen et al. provide that the purpose of the “swirler” is to swirl fuel flowing through the orifice when the valve is in an open position. As a result, Shen et al. only provide an injection charge that has a swirl. The present claims, however, provide a configuration in which some of the fuel injected is axially configured, different than the fuel injector and than the stated purpose of Shen et al. As provided in the Specification, where the valve opens fuel flows mostly axially and without a swirl toward outlet orifice 32. Only directly after this pre-stream follows a main stream formed by fuel which has flowed through swirl element 47 immediately prior to that and therefore has a swirl. Page 7, lines 29 to 32.

Ren et al. do not disclose, or even suggest, that an entry plane of an outlet orifice is arranged such that the entry plane is completely covered by a projection of a flattened face in a direction perpendicular to the flattened face into the entry plane as recited in amended claim 12. Ren et al. provide an end face which has a diameter less than the diameter of the orifice face, a completely opposite configuration than that recited in claim 12. Fig. 2. Ren et al. furthermore require that the diameter of the flat end surface is smaller than the diameter of the underlying orifice of the valve seat. Col. 2, lines 3 to 4. As a result, Ren et al. do not disclose, or even suggest, the features of claim 12. Additionally, the Office Action is expressly relying on the Specification of the present application in an attempt to provide support for the present rejection. In this regard, the Office Action states that “[i]t would have been obvious to a person having ordinary skill in the art at the time of the invention to have optimized the values of  $d_0$  and  $d_r$  for desirability dependant on certain applications (applicant's specification, page 9, line 12).” Office Action at p. 5 (emphasis added). Thus, the present rejection is expressly and improperly based on hindsight and should be withdrawn for this reason alone. Furthermore, the Office Action attempts to provide support for the present rejection based on an alleged similarity between the “outlet orifice diameter  $d_0$  which is greater than the

flattened face diameter  $d_f$ ” described by Ren et al. and the part of the needle valve illustrated in Figure 6 of the present application and described on page 9, lines 8 to 13 of the Specification. However, the alleged similarity of the injector nozzle described by Ren et al. and the valve needle end described in the Specification of the present application and illustrated in the Figures of the present application is irrelevant as to patentability of the claims of the present application.

Applicants furthermore submit that Ren et al. do not disclose, or even suggest, that an entry plane of an outlet orifice is arranged such that the entry plane is completely covered by a projection of a flattened face in a direction perpendicular to the flattened face into the entry plane as recited in amended claim 12. As more fully set forth above, Ren et al. provide a flattened face 46, of which a perpendicular projection does not cover an entry plane of the outlet orifice. Fig. 2. As a result, Ren et al. do not disclose, or even suggest, all the features of amended claim 12.

Regarding the Office Action statement that it is “inherent” that when  $d_f > d_o$  that the flattened face projection covers the outlet orifice, Applicants respectfully traverse this unsubstantiated conclusion of the Office Action. Applicants respectfully submit that Ren et al. do not disclose or even suggest a configuration of  $d_f > d_o$ . Ren et al. only describe an opposite configuration of  $d_o > d_f$ . As a result, Ren et al. do not inherently provide the features of the present invention as Ren et al. actually teach away from this feature.

In rejecting a claim under 35 U.S.C. § 103(a), the Examiner bears the initial burden of presenting a prima facie case of obviousness. In re Rijckaert, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). To establish prima facie obviousness, three criteria must be satisfied. First, there must be some suggestion or motivation to modify or combine reference teachings. In re Fine, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). This teaching or suggestion to make the claimed combination must be found in the prior art and not based on the application disclosure. In re Vaeck, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). Second, there must be a reasonable expectation of success. In re Merck & Co., Inc., 800 F.2d 1091, 231 U.S.P.Q. 375 (Fed. Cir. 1986). Third, the prior art reference(s) must teach or suggest all of the claim limitations. In re Royka, 490 F.2d 981, 180 U.S.P.Q. 580 (C.C.P.A. 1974). As more fully set forth above, it is respectfully submitted that the combination of Imafuku et al. and Shen et al. does not disclose, or even suggest, all of the limitations of claim 12 and that Ren et al. do

not disclose, or even suggest, all of the limitations of amended claim 12. It is therefore respectfully submitted that the combination of Imafuku et al. and Shen et al. does not render obvious amended claim 12 and that Ren et al. do not render obvious claim 12.

As for claims 13 to 21, which ultimately depend from claim 12 and therefore include all of the limitations of amended claim 12, it is respectfully submitted that neither the combination of Imafuku et al. and Shen et al. nor Ren et al. renders unpatentable these dependent claims for at least the same reasons given above in support of the patentability of claim 12. In re Fine, *supra* (any dependent claim depending from a non-obvious independent claim is non-obvious).

As further regards claim 14, the Office Action's reliance on In re Boesch, 617 F.2d 272, 205 U.S.P.Q. 215 (C.C.P.A. 1980) is misplaced. Before the determination of optimal or workable ranges of a variable can be characterized as routine experimentation, a particular parameter must first be recognized as a result-effective variable, *i.e.*, a variable that achieves a recognized result. In re Antonie, 559 F.2d 618, 195 U.S.P.Q. 6 (C.C.P.A. 1977). The references relied upon do not even suggest that a ratio of diameters claimed in claim 14 is such a results-effective variable, and the Office Action does not even assert that the ratio of diameters constitutes a results-effective variable. It is therefore respectfully submitted that claim 14 is allowable for this additional reason.

## **VI. New Claim 21**

New claim 21 has been added herein. It is respectfully submitted that claim 21 does not add any new matter and is fully supported by the present application, including the Specification. Since claim 21 includes features analogous to the features included in claim 12, it is respectfully submitted that claim 21 is patentable over the references relied upon for at least the same reasons given above in support of the patentability of claim 12. For example, claim 21 recites that a projection of a flattened face in a direction perpendicular to the flattened face into an entry plane completely covers the entry plane. As more fully set forth above, none Imafuku et al., Shen et al. and Ren et al. discloses, or even suggest, at least this arrangement.

**VII. Conclusion**

It is respectfully submitted that all pending claims are allowable. All issues raised by the Examiner having been addressed, an early and favorable action on the merits is earnestly solicited.

Respectfully submitted,

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